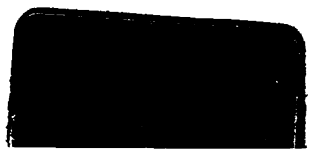

BY THE SAME AUTHOR.

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NOTES EMBODYING

RECENT PRACTICE

IN THE

SANITARY DRAINAGE

OF

BUILDINGS,

WITH

MEMORANDA ON THE COST OF PLUMBING WORK.

BY

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PREFACE.

A great philosopher once said that "the fault of most books is their being too long." The author's aim has been to avoid this fault, by stating in plain language, as briefly as possible, what constitute the leading requirements of sanitary drainage as applied to buildings. The first and third part of this little book deal with the general principles of house drainage, while the second part discusses in detail the requirements as to material, workmanship and arrangement of sanitary plumbing. These, it is believed, will be found particularly useful by architects and engineers in preparing complete plumbing specifications for all classes of buildings. The fourth part, giving memoranda on the cost of plumbing work, will, it is hoped, be found by many to be a welcome addition.

It is suggested that those who desire to obtain a more complete knowledge of this important branch of interior house construction should read, in connection herewith, the author's former works, which this volume is merely intended to supplement.

THE AUTHOR.

39 UNION SQUARE, WEST,
NEW YORK CITY, May 1, 1887.

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I.

RECENT PROGRESS IN HOUSE DRAINAGE AND PLUMBING.

RECENT PROGRESS

IN

HOUSE DRAINAGE AND PLUMBING.*

Among the many practical and utilitarian details of interior construction tending to increase the comfort and convenient arrangement of houses, none occupy a more important position than those relating to the fixtures, traps and pipes which introduce and distribute into our buildings a supply of pure water for household use, and afterward remove from them the liquid and semi-fluid foul wastes, designated by the general term house sewage.

Our modern homes present, in the vast number of pipes of all sizes, kinds and character which traverse them in all

* This paper was originally prepared for, and appeared in, the Chicago *Inland Architect*.

directions, not only across the basement or cellar, but also from cellar to garret, an appearance quite different from the houses built by our ancestors a century or more ago. A modern residence fairly abounds with pipes for the conveyance and distribution of illuminating gas into rooms and halls; with hot and cold water pipes; with pipes for heating purposes, carrying steam from boilers, or returning to them condensed water; with channels or conduits carrying fresh air into the cellar, to the heating apparatus, or directly into living or sleeping rooms; with flues and registers for the admission of pure, warm air, ventilating flues for the removal of vitiated air, and chimneys for carrying off smoke from the combustion of fuel; with speaking tubes, telephone wires, tubes enclosing wires for electric bells and for electric lighting; and finally with waste and vent, soil and drain pipes for the removal of household wastes through plumbing appliances, which are more or less scattered in all directions over the principal floors of the house.

These are what the tempting language of the advertisements of shrewd real estate agents or speculative builders comprise under the term "*modern improvements*," and the minds of American householders have been accustomed to the latter to such an extent that even small houses rarely remain without some of the above named comfort-promoting arrangements, and that a much higher price is willingly paid for the purchase or lease of a building well provided with them. Of course, with lighting and heating apparatus of all sorts and kinds in a house, requiring intelligent care and frequent inspection, but generally left to be manipulated by ordinary servants, and with the still prevalent custom of having much of the work concealed, partly or wholly, in walls, partitions, or between floor-beams, repairs are apt to be numerous, disagreeable and costly; and to avoid them, even in the early days of the introduction of such improvements, architects, builders and owners rarely failed to specify certain re-

quirements, or neglected to make use of certain tests, to assure themselves that the pipes intended to convey water, steam, hot air, fire and smoke, and illuminating gas, were tightly jointed so as to prevent the unwelcome or unwholesome escape of any of their contents into the house.

But with sewer pipes, soil and vent pipes, fixtures and traps, the usual practice has been different. The requirements in the majority of instances were less stringent, the danger arising from defective work was disregarded or overlooked through ignorance, indifference and folly, and the owner was usually less inclined to spend a sufficient amount of money for such work, except so far, perhaps, as the desire went to make a handsome display of richly decorated bowls, plated or gilt faucets, and elaborate ornamental woodwork, corresponding in style and elegance to the artistic decoration and interior finish of the rooms and the richly adorned outside of the building. It was idle, in those days, to attempt to speak to builders of

a *sanitary* arrangement of plumbing work. Architects, consequently, paid less attention to the subject than it rightfully demanded.

But the world moves, and, although progress in the art of properly draining houses seems to have been rather slow, yet in the past few years a decided change for the better has been noticeable. A stir has been made in the interest of healthy homes and healthy living, largely by the dissemination of useful knowledge on the subject through newspapers, popular magazines, sanitary journals, pamphlets and health reports. The indifference of the public gradually vanished, sanitary laws began to be better understood, and the evil influence upon health of faulty plumbing work became apparent. A loud demand for healthful houses arose, sanitary surroundings were eagerly sought for, and the consequence was that architects, to meet the wishes of their clients, were obliged to give the subject some thought and attention. Builders, in their turn, were not slow to

guard their pecuniary interest by, at least, a superficial endeavor to offer what the public demanded, and hereafter *sanitary* plumbing and *sanitary* heating became the leading features of many advertisements of speculative house builders.

The greatest step forward, however, was made, when in our large cities plumbing work became subject to board of health rules and regulations. At first there was, as might have been expected, considerable ill-feeling against compulsory measures, especially against the intrusion of the ever-vigilant sanitary inspector into the interior of private houses. The sacredness of personal rights, as embraced in the old saying, "My house is my castle," was apparently violated. But a moment's consideration of the vast multitude of houses built as cheaply as possible, to sell or to rent as profitably as possible, will convince any one how necessary such inspection must be. By way of digression, we would like to see a similar inspection enforced by law regarding the fireproof construction of buildings.

Dwellings and apartment houses are frequently sold or rented as "*fireproof*," when in reality they are little better than tinder-boxes, falling a quick and easy prey to the flames of a once started conflagration.

The beneficial effect of plumbing laws extends principally to the vast number of householders and families in large cities, who are compelled to live in hired dwellings, apartments, or tenements, and who cannot protect themselves against preventable sickness due to unsanitary surroundings, in particular to defective drainage. The standard of plumbing work in such buildings, where all items of expense are apt to be reduced to a minimum, became appreciably improved and the condition of healthfulness increased, by giving its control to a board of health. Even if no other good results had followed the enforcement of rules and the official inspection of all work in new buildings, the single measure, compelling the owner of each new house to file plans and specifications clearly showing and describing

the system of plumbing to be introduced into the building, had a wholesome effect upon the manner in which such work, henceforth, was to be handled by architects as well as plumbers. Since no work could be commenced in any building before the plans and specifications filed had been approved by the board of health, the subject of drainage and plumbing received its share of proper attention at an early stage of the construction of the building.

The benefits derived from these measures have, it is true, by no means remained without some drawbacks, which, though not necessarily fatal to the results, still, to some extent, hinder as rapid a progress as might have been expected. To these I desire to make a brief allusion. So far as owners are concerned, we now often find too much reliance placed by them in the supervision exercised by boards of health. Even with a multitude of efficient inspectors in their employ, this supervision must, of necessity, be very general only, and with the still universal

tendency of covering up and burying out of sight those "unsightly pipes and fixtures" much defective work *may* escape the eye of an Argus-eyed and faithful inspector. There is, moreover, in every plumbing job a chance for much botched work, not necessarily involving a violation of any plumbing regulation. On the other hand, since some points relating to house drainage are yet disputed, it cannot be expected that plumbing regulations will become perfect for some time to come. Even the most complete regulations which I have seen contain certain rules and requirements which appear to me to be of doubtful value. Considerations towards manufacturers of plumbing goods will generally prevent boards of health from prohibiting the use of appliances which all sanitarians have long ago condemned. Again, it is obvious that such general regulations must be quite inadequate and incomplete when applied to work in very large and extensive structures. They cannot include rules regarding all the details of the work, for,

as is natural, board of health laws can only insist upon and enforce a certain minimum of improvements.

As regards architects, judging from a somewhat extensive personal experience with a number of plumbing specifications with which I came in contact during the past few years through the practice of my profession, much improvement is noticeable, together with a desire to keep well informed about the progress in the principles and the practice of house drainage. Yet the majority of their specifications continue to be written in a fashion-like manner, without sufficient attention to the details and to improved methods and appliances, and failing to lay proper stress upon the quality of the materials, upon the workmanship required, and upon proper and stringent tests regarding the pipe system. Nor is the inspection of such work a thorough one, and the testing of the pipe system by pressure, if specified, is rarely insisted upon by architects. In those cities where boards of health require the filing of plans and

specifications, it became customary with architects to use blank specifications, printed and furnished by the health board which contain as a guide the essential requirements, the blank spaces in them being simply filled out by architects, who would add a few additional requirements in writing. I do not know whether or not the use of such blank specifications is made compulsory, in which case no blame could fall upon architects for using them. What I do know is that such specifications, as applied to a large building, must necessarily be quite incomplete, insufficient, and imperfect, and often appear unsystematic in the arrangement of the subject matter.

The object of a house drainage system has long been understood to be to remove from dwellings at once, and as thoroughly as possible, all liquid waste matters before they undergo decomposition and emit unwholesome gases of putrefaction. In its widest meaning the term "house drainage" is made to include the removal of

surface water from roofs and yards, as well as of subsoil water from the ground upon which a building is erected. Strictly speaking, we should distinguish between *drainage* and *sewerage* of a building, the former term referring to the removal of all clear water (roof water, surface water and subsoil water), the latter to that of fouled waters from the household (sewage proper.) It is often of very great importance to keep the one separate from the other, as, for instance, in the case of isolated country houses, where sewage is conveyed by *tightly-jointed* sewer pipes to a flush tank or other tight receptacle, from which it is disposed of by irrigation or sub-surface irrigation upon or underneath lawns or grass land, while subsoil water is removed by *open-jointed* land drains to the nearest watercourse, brook or open ditch. A third system of pipes generally carries, in the case of rural dwellings, the rain falling upon the roof into a tight cistern or storage tank for clean water. With city houses it is sometimes, though not

often, feasible to carry out the same separation, at least as far as the subsoil water is concerned, provided a special line of subsoil drains has been laid in the street in the same trench with the sewer. As a rule, in the case of narrow city lots, one outlet is common to the drain and the house sewer, but it is one of the most important duties of those who advise in such matters to consider the best means for safely disconnecting the open-jointed tiles from the house or street sewer, to prevent the back flow of sewage and—still more important—of sewer air from the house sewer into the tile drains, from where it would easily diffuse into the cellar and rise into the upper floors of a house.

The removal of subsoil water, or at least the permanent lowering of its water level to secure dryness of the house, is equal in importance, from a sanitary point of view, to a proper system of house sewerage and plumbing. It is best accomplished by lines of small-sized, common, porous land drains, laid at least two

feet below the cellar floor, with open joints, protected by a collar, wrapping paper or muslin, against chokage from dirt, all delivering into a main drain, sloping toward the outlet, which may be either a gutter in the road, an open ditch or watercourse, or else the sewer in the street. In the former case no further protection is needed at the outlet, except a strong, fixed grating, to prevent the entrance of mice or rats. Where subsoil water is discharged into sewers an efficient disconnection should be provided by a deep-seal water trap, kept constantly filled by some automatic device in connection with the water supply of the house.

In advising clients in regard to subsoil drainage, I generally call their attention to a few points regarding healthful house construction, not strictly belonging to, but intimately connected with, the ventilation and drainage of dwellings, and which in most cases remain unheeded by architects and builders. I refer to the perfect isolation of the house from

the ground upon which it stands, and from the water and air contained in the pores of the soil. It is not enough to provide for subsoil drainage under the house; its walls are frequently exposed to moisture, or even water veins penetrated in digging trenches for foundations. Dampness of walls is of frequent occurrence in cheaply built houses as well as in the better class of houses where no attention is paid to such apparently insignificant details. Again, the damp vapor of ground air and frequently unhealthy exhalations from polluted soils would constantly rise into the cellar, especially if assisted in their upward passage by the so-called "suction" of house chimneys, unless provision is made for a thorough isolation of the cellar from the ground below by a tight cellar floor, which at the same time will prevent the rise of subsoil water. Asphaltum has proved a most valuable material for foundation walls, damp-proof courses, as well as for the cellar floor, and efficiently

accomplishes this much to be desired complete isolation.

A safe drainage of the subsoil being arranged for, we must next provide for the speedy and complete removal of the house sewage, consisting of waste water from flushing urinals and water closets, together with human excrements and urine, of dirty water from personal ablutions in wash-bowls and all forms of bathing tubs, of chamber slops, of foul laundry water and water used for rinsing cooking vessels and cleaning dishes. The amount of sewage will be largely increased at times if the rain water falling upon the roof and upon paved areas and court-yards is also admitted into the house sewer. Whether or no this should be done will depend upon the system of sewerage existing in the place, but even where the street sewers are designed to carry and to ultimately receive more or less rainfall, the question arises whether it is better to have within the house a single system or a double set of pipes, one for sewage and another for rain

water. This question cannot be decided in a general way. It becomes necessary to take into consideration the special conditions speaking for and against such separation, and thus each building becomes a problem in itself. This much may, however, be stated, that it is preferable to keep the vertical pipes leading the water from the roof separate from vertical soil or waste pipes.

In a brief article on the subject it is, of course, impossible to refer to the many details of plumbing work.* I must necessarily restrict myself to a statement of the *leading requirements* and *general principles* governing the planning and arrangement of such work. What, in the light of present definite knowledge of the

* The reader may find the subject thoroughly discussed in the author's works:—House Drainage and Sanitary Plumbing, 2d Edition, 1884.

Hints on the Drainage and Sewerage of Dwellings, 2d Edition, 1884.

Domestic Sanitary Appliances (in press), 1887.

Guide to Sanitary House Inspection, 1885. See also the article "Maxims of Plumbing and House Drainage," page 45 of this book.

subject, I consider as essential, and as applicable *without modification* to all classes of buildings, to the drainage and sewerage of the largest and most expensive mansion, the smallest city house or suburban cottage, of schools, hospitals, factories and tenement houses, may be summarized as follows:

I should use within a building metal pipes only, principally iron pipes, with the exception of the short branch waste and supply pipes, which may be of lead. I should commence with the iron drain at least five feet beyond the foundation walls, so as to make sure against breakage by settlement of walls, and to further guard against the latter serious calamity I should always advise to turn a relieving arch across the wall where the pipe passes out. In the case of country houses with a water supply derived from a well in the vicinity of the house, I should advise carrying the house sewer of iron to a point well beyond the probable limits of the drainage area of the well. I should recommend to use, even in those houses

where due regard to economy must be had, extra heavy pipes of uniform thickness and tested under pressure before use, and before applying a protective coating of coal tar or a similar substance, so as to avoid any imperfections in the pipe which may be covered up by the enameling or other process. I should also insist, at a later stage of the work, upon a proper test of the pipe joints in order to make sure that the whole system is air-tight as well as water-tight beyond any doubt. I should advise to use a diameter of only four inches for the main pipe of a single house of ordinary size, and should restrict the size of the main drain of larger buildings to five and six inches, preferring to arrange two or more systems of six-inch main sewers for the largest institutions, in place of one eight or ten-inch pipe.

I should, wherever possible, banish all plumbing fixtures from the cellar floor, in order to carry the house drain in plain sight either along one of the cellar walls, or else suspended from the basement floor beams.

I should give to the pipes in the cellar all the fall possible, in order to insure a good cleansing velocity of the flow in the main pipe, and wherever the needed fall could not be obtained, I should advocate the use of flushing tanks of some kind at the head of the drains. I should suggest strongly to support the main drain and its branches by brick piers, placed at suitable intervals, and especially at the junction of all upright pipes. I should take care to have all junctions made with Y branches instead of T branches, and all changes from the direct line made with curves of an easy sweep. I should recommend the use of cleaning hand-holes, at intervals, along the main line, at junctions, bends, and near traps, but I should also strongly counsel the thorough and tight closing of all such inspection openings.

I should carry all upright soil pipes, and all lines of waste pipes, in the straightest practicable course, and with as few elbows as possible, up to and through the roof, and should advise making this extension in no case less than four, and

preferably six, inches diameter, to provide a free outlet above the roof. This outlet I should carry well above the roof line, and should keep it as far away as possible from any chimney flues, ventilating shafts, dormer windows, etc. I should firmly insist upon a copious and constant circulation of fresh air through all drain, soil, waste and vent pipes, and with this end in view, should provide a suitably large inlet for air, at the lowest point of the system, and extend all pipes at least full size above the roof, doing away entirely with any obstructions in the shape of ventilators, cowls, caps, or, worst of all, return bends, covering the mouths of pipes. If there is ground to fear an accidental or malicious obstruction of the pipes, I should urge the use of only a wire netting, or a common leader guard inserted into the pipe mouth, or, what is better, I would extend the pipes sufficiently high to keep their open mouth out of reach of mischievous persons.

I should recommend locating all fixtures as much as possible in vertical

groups, in order to get a straight, simple, and direct arrangement of soil and waste pipes, and to reduce the length of branch waste pipes, thereby securing a more thorough and direct discharge of fixtures. I should never use a soil pipe larger than four inches inside diameter, even for the greatest possible number of fixtures, and should limit the size of upright waste pipes for sinks, basins or baths to two inches.

Regarding plumbing appliances, my advice would always, even in the case of the most costly residences, consist, for obvious reasons, in reducing their number, and consequently the amount of plumbing work, as much as practicable, and to avoid placing fixtures in spare rooms, where they would not be constantly used. I should further recommend to locate all fixtures in well-lighted and well-ventilated rooms, thereby insuring a proper use, and a better care of the appliances. I should abolish all plumbing from sleeping rooms, confining the same

to the bath room, the kitchen, the laundry, the pantry, and to well-lighted closets.

Although the subject of warming and ventilation cannot be here considered, yet I will mention that I should insist upon a proper and constant change of air in the bath rooms and water closets. This involves the introduction and thorough diffusion of an ample supply of pure air from outside, moderately warmed (in our climate during at least seven months of the year), not only to increase the comfort of the bath room, but also to prevent the freezing of supply pipes, or standing water in traps. It also requires the removal of the foul air, which can be attained in a simple, yet efficient manner by arranging a gas-burner in an outlet flue of ample size. These are matters which begin to be better understood in the construction of houses, but I desire to call attention to a defect which I have frequently noticed in otherwise well-ventilated houses, namely, that where a strong suction exists from the outlet-flues or chimney-places provided in rooms,

halls, or staircases, the supply of air, and sometimes noisome odors, are frequently drawn from a bath room or slop closet. Hence it should be borne in mind, in arranging a general system of house ventilation, that the ventilation of apartments containing water closets, urinals, slop hoppers, or other fixtures, requires special attention, and that to be effective and reliable there should, preferably, be a constant movement of air from the other parts of a house toward and into the bath room; in other words, it is of prime importance to arrange a well-drawing outlet flue in a bath room or water closet apartment, which would tend to create a slight vacuum in said room. Sufficient air being thus constantly removed, fresh air will easily come in to take its place, provided it is admitted in ample quantity into the other parts of a house. Where a building is ventilated by *plenum ventilation*, it is better not to include bath-rooms or water closet apartments in such a system.

It should be the aim to have the whole

plumbing work arranged as simply as possible. Supply pipes must always be so located that they will not freeze in cold weather, and it is preferable to keep them away from outside walls, unless special protection is given them. Householders, having lived during a winter in an exposed country house, are always ready to appreciate measures tending to the protection of water pipes against frost.

Whenever I am left untrammeled by prejudice I always arrange all plumbing work in an open manner, leaving all appliances, traps, supply and waste pipes *fully exposed to view*. The advantages gained hereby are two-fold. In the first place, I secure a better and more thorough workmanship of those parts of the work, which, being usually tightly boxed up, are very apt to be less carefully finished, and this is true not only of the plumber's work, but also of that of the carpenter and plasterer.

From a sanitary point of view, and likewise for other reasons, it is quite import-

ant to have all those unsightly holes where pipes pass through floors and ceilings tightly and permanently closed, to prevent diffusion of air from one story to another. I recently examined a bath room in an apartment house, where at each cold spell such a violent draft was rising through a pipe channel leading from the cold basement to the upper floors, along the soil and supply pipes, as to completely chill, and cause the freezing up of the water in, the pipes, much to the annoyance of the house owner, who could hardly get along without the plumber as soon as the thermometer would reach the freezing point, yet the plumbing in this building was done "in accordance with all the board of health rules" and had successfully passed inspection.

A second advantage obtained by leaving plumbing work fully exposed to view is that there is a better circulation of air around the fixtures, that the cleaning and scouring operations of servants are much facilitated, that all parts of the work are easily accessible and readily inspected,

and that repairs are less frequent, and if they become necessary that there is little or no tearing up of wood work, floors, and base boards. An open arrangement also aids in enlightening the anxious minds of some householders concerning the "hidden mysteries of plumbing work." What is true of plumbing fixtures is, of course, equally applicable to the system of pipes in a dwelling. I strongly advise keeping all pipes outside of walls or partitions, locating them, where possible, in closets or in inferior rooms. This enables one to inspect at any time any pipe joints or to readily reach any stop-cock or valve, should it be necessary to shut off the water from any pipe. I generally dispense with unsightly lead safes under fixtures, believing that with the open arrangement a leakage cannot remain unnoticed for a sufficient length of time to work serious harm, especially where walls (to the usual height of wainscoting) in kitchens and bath rooms are made water tight, and finished in tiles, plain or ornamental, or enameled brick, and where floors are finished with

marble, tiles, slabs of slate, cement, or in simple *terrazzo* work. If required I arrange a drip pipe to remove any water from leakage, which pipe must always be kept entirely disconnected from any soil or waste pipe.

As to the fixtures proper, I should select, for an inexpensive cottage as well as for a luxuriously furnished city residence, those of a simple character, with a smooth, and non-absorbent surface. The exact material of the fixtures is often mainly a question of cost. For water closets, slop hoppers, and urinals, which latter, however, I avoid in private houses, I should give preference to those with a small fouling surface, made in annealed glass or in earthenware. I recommend, of course, using water closets without any mechanism or moving parts liable to get out of order. I would, wherever I could, avoid the use of fixtures requiring a hidden overflow pipe. Bath tubs of all kinds, wash bowls, pantry sinks, water closets and urinals may now be had of such a form and construction as to do away entirely

with concealed overflow channels, which are often the cause of annoying odors.*

I should locate fixtures as near as practicable along a soil or waste pipe, to avoid the always objectionable branch wastes under floors. I should endeavor to place the fixtures of different floors in groups arranged as nearly as may be vertically above each other, to reduce the number of pipe stacks. I should also aim to give to each fixture an independent and direct discharge into the vertical pipe. I should insist upon the separate, safe and secure trapping of every fixture, and should prefer, if they were obtainable, as they no doubt will be at a future day, self-cleansing and seal-retaining traps, placed as close to the outlet of fixtures as possible, and made partly or entirely of glass, with the water seal fully exposed.

I should make arrangements to secure to each fixture in a building an ample and never-failing supply of water. In

* For a discussion of plumbing appliances see the author's books in foot-note on page 25, particularly his "Domestic Sanitary Appliances."

the case of water closets, slop hoppers and urinals, I should always use a separate flushing cistern for each fixture or group of fixtures, while as regards the other fixtures I should give preference to those arranged and constructed in a manner so as to constitute in themselves a small flush tank, thus securing by their quick discharge (through outlets larger than commonly in use) a thorough cleansing and scouring of the waste pipe serving them.*

I should, finally, never have a direct connection between any water cistern, a refrigerator or ice chest in a house and the drains or soil pipes, and I should guard with particular care the purity of the supply for drinking purposes.

I have, as far as the space at my disposal permits, outlined the leading requirements of a proper system of house drainage, and I confidently assert, from practical knowledge and experience, that,

* Fixtures having this important advantage are described in the author's work on "Domestic Sanitary Appliances."

wherever they are conscientiously followed, satisfactory results cannot fail to be secured.

A few points, however, have not been referred to. There is, for instance, the "trap on the main drain" question, which is still agitating the minds of many. I do not feel inclined to be dogmatic about it, for in my own practice I have never followed an iron rule, but have, on the contrary, in each special case, carefully considered and weighed the circumstances and conditions affecting the question. I always use a trap on the line of the drain, if the latter discharges into a cesspool or any form of tank in which sewage is stored for some length of time. I generally advise the use of a trap where the house drain connects with a foul sewer, as in the majority of cases in our large cities. If I use a trap, I should insist upon having it easy of access (but not so as to be exposed to freezing), and provided with proper cleaning hand-holes. Where a house drains into a street sewer, forming part of a well-planned general system of well-flushed

sewers, ventilated by open soil pipes in the houses, constructed under supervision of a competent engineer, I should not object to the omission of the trap, always provided the work in the house is thoroughly well done. Where the owner would not mind the additional expense, I should probably prefer to arrange for the ventilation of the sewer by having a pipe carried up to the roof, along the outside of the house, thus preserving a complete disconnection of the house interior from the sewer. Whenever I use a trap, I should also arrange a fresh air inlet, to induce a current through the soil pipe system. I should, however, strongly advise my clients not to terminate the inlet in a box in the sidewalk, covered with a grating, as is now so often done, for such a grating frequently becomes obstructed and closed in winter time. Nor should I carry the fresh air pipe up to the roof. Where to arrange the inlet is a matter which can be determined only in each special case, and which ought never to be restricted by a hard and fast rule,

often entirely defeating the purpose for which the inlet was established.

The question of material most suitable for drains, soil pipes, waste and supply pipes, has not been alluded to, nor have I, in my above recommendations, referred to the many kinds of water seal and mechanical traps advocated to exclude sewer air from the fixtures. I do not feel disposed to enter into a discussion of the merits and disadvantages of the "venting" of traps, the object of which is largely to prevent siphonage. Experiments have established, with a sufficient degree of certainty, the fact that the self-cleansing S-, P-, or running traps, cannot be depended upon always to retain their water seal against siphonage, unless air is admitted at the crown and sewer side of the trap, either by some anti-siphoning trap attachment, or by a so-called "back-air" pipe, of ample size. Consequently, I should not use such traps without providing such protection as the remedies mentioned afford. Later experiments have shown that an air pipe

is not a reliable protection against siphonage in *all* cases, especially where the course of the air-pipe is long and tortuous, and that where fixtures are not in constant use, it furthers the evaporation of the water in traps, and hence endangers the safety of plumbing work. That it increases the cost of plumbing, and hinders simplicity of arrangement, must be conceded by all. Thus, while it offers certain advantages in some instances, there are other cases where the disadvantages predominate. It remains then, to be decided, only after a thorough and intelligent consideration of all conditions, whether a seal retaining water seal trap safe against back pressure, siphonage or other influence, or an anti-siphoning trap attachment of some kind, may not be preferable. The question cannot, in my judgment, be decided in an off-hand way. Being of grave moment for the safety of the inmates of a house, the question of trapping should receive an earnest, thoughtful and unprejudiced consideration. Unfortunately, discussions on this point, in sani-

tary and architectural journals, have not always been divested of useless and much to be deprecated personalities.

As with traps, I also prefer to omit lengthy descriptions of any special plumbing fixtures. There are now a number of each kind in the market, possessing merits and giving satisfaction, which a judicious house owner may select, guided by the above hints.

In conclusion, it must always be borne in mind, that no system of plumbing or drainage will work forever, without proper care, attention and periodical inspection; that stagnation of water or air must be avoided in drain, soil and vent pipes, as well as in traps; that the water in the latter should be frequently changed; and that, in the *tight jointing*, *safe trapping* and *constant ventilation of pipes*, together with the *frequent flushing* and *thorough cleansing of fixtures*, consist the principal safeguards of a proper system of house drainage and plumbing against entrance and diffusion of noxious sewer air.

II.

MAXIMS
OF
PLUMBING
AND
HOUSE DRAINAGE.

The following notes on plumbing will show more particularly what requirements should be made in regard to materials, workmanship and arrangement of the plumbing work in houses. They should be looked upon and used merely as a framework, upon which a specification, suited to each special case, is to be constructed. They are intended primarily to suggest points that require careful consideration, but they also constitute instructions for the guidance of the mechanics engaged in such work.

MAXIMS

OF

PLUMBING AND HOUSE DRAINAGE

To obtain a safe and secure system of drainage and plumbing in a building, to secure to a house immunity at all times from sewer air, and to prevent any subsequent annoyances incident to bad arrangement and careless workmanship in water pipes and plumbing appliances, it is necessary to observe the following points:

First, to have the system of fixtures, traps, supply and waste pipes well planned and arranged in accordance with the best rules.

Second, to have the work itself constructed in a thoroughly able and efficient manner by competent mechanics and under proper superintendence.

Finally, after the work is all completed and put to use, to have it managed with intelligence, properly taken care of, and examined from time to time, as to its continued soundness and freedom from defects, as is done with all other mechanical apparatus and machinery.

Hence, the subject naturally divides itself into the following sections, viz.:

A. Principles which should govern the planning and location of plumbing work in dwellings.

B. Rules regarding the proper construction of the work, in particular as to

(1) *Materials.*
(2) *Workmanship.*
(3) *General Arrangement.*
(4) *Tests.*

C. Suggestions as to the management and proper care of plumbing apparatus.

It is well known that much of the success of a system of house drainage and

plumbing, to say nothing of the convenient and compact grouping of fixtures and the thereby reduced cost of the work, depends upon a judicious planning and arrangement by the architect or person designing the plans of the building.

The rules regarding the proper construction of the work will contain the principal requirements which, in whole or in part, should be embodied in plumbing specifications for all kinds of buildings. It is, however, absolutely necessary, in order to make such a specification complete and adapted to any particular building or dwelling house, that in addition to general requirements the specification should contain a detailed enumeration of all plumbing appliances (fixtures, traps, supply and waste pipes, tanks, boilers, flushing cisterns, stop-cocks, faucets, etc.) required in the building; a detailed and accurate description of the location of the plumbing fixtures, and of the special apparatus wanted, and a minute description of the course of all hot and cold water service pipes, soil, drain, waste, vent, overflow

and drip pipes. In every case floor plans and all needed sections of the building should be added, showing clearly the proposed system of drainage and water supply.

From a long practical experience with such details of interior finish in newly erected buildings, I am convinced that it is quite important, in order to secure good results, to prepare a plumbing specification with scrupulous regard to details and with much thoroughness and exactness. It is a great mistake on the part of architects or owners to suppose that such rules and regulations or printed blank specifications, as the boards of health in our large cities now require to be filed, are sufficiently detailed to prevent gross carelessness or deception on the part of unscrupulous plumbing contractors. Plumbing regulations, as framed by boards of health, are good in their way, although undoubtedly susceptible of much improvement. They are altogether too complicated, too detailed in many respects, while not strict enough in others.

All those which have come to my knowledge permit certain things which every sanitary engineer worthy of the name absolutely condemns, and, on the other hand, they specify or require things, some of doubtful utility, and others absolutely objectionable, and which no one who has impartially investigated the subject can conscientiously approve.

The suggestions named under (C) refer especially to householders and servants. It has become a recognized fact that a properly constructed drainage system of a house must be intelligently used, and needs constant care and attention on the part of the householder to maintain it in good order. Especially is this true of the vast number of houses occupied only during a part of the year, such as summer residences, summer hotels, seaside and mountain cottages, etc. It also refers to city houses, many of which are closed and vacated during the hot summer months. How to leave plumbing work in such houses during winter and during summer, without incurring the risk of finding, on re-

turning, that the pipes and traps have been frozen and burst, or that the rooms, walls, carpets and furniture are saturated with sewer air, is a question to which a certain amount of attention might with advantage be paid by every householder.

A. Rules regarding the planning and location of plumbing work in dwellings.

Avoid a useless multiplication of plumbing fixtures. Let the amount of plumbing work in a house be reduced as much as possible. Above all, avoid locating fixtures in unoccupied or spare rooms.

Do not place plumbing fixtures of any kind in sleeping rooms, nor even in unventilated closets adjoining them.

Plumbing fixtures, especially water closets, urinals and slop hoppers, must always be located in well-lighted and well-ventilated apartments.

Always arrange fixtures so as to be concentrated, as much as is consistent

with convenience in use, in compact groups. Have as few vertical lines of pipe as possible. Avoid long horizontal runs of pipe.

Arrange all plumbing work in a simple manner, with as little complication as is attainable.

In small cottages place the bath room as nearly as possible over the kitchen, in order to reduce the amount of piping, and to simplify the whole work.

In small houses it is preferable to separate the water closet from the bath room and to give to each of them a well-lighted and ventilated apartment.

In toilet and dressing rooms, adjoining bedrooms, the water closet, lavatory and bath tub may, however, be arranged together.

Avoid locating any fixtures, such as laundry tubs or servants' water closets in the cellar.

Servants' water closets, slop hoppers and housemaids' sinks should never be located in dark, out-of-the-way corners.

Avoid locating any supply pipes on out-

side walls, especially if the house stands detached and exposed.

In country houses occupied during the winter, do not locate the bath room and the water tank in that corner of the building which is most exposed to the weather and the direction of the coldest wind (generally the northwest corner).

Place all soil, waste and supply pipes outside of walls or partitions. Let pipes pass in sight through closets, and leave them fully exposed in bath rooms.

Avoid dead ends in all except short branch waste pipes.

In larger houses arrange means for drawing hot and cold water on every floor. Provide a slop hopper on bedroom floors for the convenience of the servants.

Avoid having plumbing apparatus on floors where you are not sure of a constant, abundant and never-failing supply of water.

Openings in the cellar floor, connecting to a house sewer, should be avoided as unsafe, even if properly trapped.

Overflow pipes and waste pipes not in daily use are objectionable.

Arrange all fixtures, wherever possible, so as to have distinctly independent outlets into the main soil pipe system.

Quick-emptying fixtures, constituting a small flush tank for the waste pipe attached to them, and arranged without concealed overflow channels, are preferable to other kinds.

Select plumbing fixtures of a strong, durable, smooth, non-absorbent and non-corrosive material, of a simple construction, and with as little movable mechanism as possible.

Arrange all fixtures in an open manner. Avoid carpentry of any kind, enclosing plumbing apparatus, as much as possible.

Avoid lead "safes." Floors and walls about plumbing fixtures should preferably be made water-tight, and covered with slate, marble or encaustic tiles.

Wherever much grease is wasted, provide a suitable grease trap.

Keep, as a guide in case of future examinations, plans showing the location of all drain pipes, traps, access holes, stop-cocks, etc.

B. Rules regarding the proper construction of the work.

In the following are given the principal requirements, which, in whole or in part, should be embodied in plumbing specifications for all kinds of buildings. The subject is subdivided under the headings; (1) General Conditions; (2) Materials; (3) Workmanship; (4) General Arrangement of the Work: (5) Tests of the Work during construction and after completion.

I desire, however, to have it distinctly understood that the following is in no sense intended to be, or to be used as, a general plumbing specification, which can be copied *verbatim*, or which, by filling in lines usually left blank for the convenience of architects, may be readily adapted to any kind of work. The following notes should only be considered a help in preparing a plumbing specification. If intelligently used, I have no doubt they will prove useful to those who are anxious to write a good specification.

1. General Conditions.

All the work contemplated, shown on the floor plans and in the sections of the building, and described in the specification, shall be done in the best and most workmanlike manner, to the satisfaction of the superintendent and the owner.

The plumber must furnish all material and perform all labor required to finish the work contemplated in the specification in a substantial manner.

He must do all his work promptly as the building progresses, and must in particular not delay other contractors nor interfere with their work.

The contractor is not to sub-let the whole or a part of his work without the written approval of the owner or his representative.

The plumber must lay out his own work correctly according to the floor plans, and is to give his personal superintendence to the work.

The superintendent shall have access to the work at all times, and shall be sole

judge of the quality and fitness of the materials used, and of the character of the workmanship.

No pipe, fitting, or work of any kind to be closed up or hidden from view before it has been examined and approved by the superintendent. Any unfaithful or imperfect work or defective material that he or the owner may discover before the work is finally accepted, shall be immediately corrected, and any pipe, fitting, trap, fixture or material of any kind which in the superintendent's judgment does not conform with the requirements of the specification, shall be at once removed and replaced at the contractor's expense by satisfactory work and material.

The plumber shall be guided in his work by both drawings and specifications. Preference must in all cases be given to figures or memoranda, and only where these are not given, scale measurements may be taken. Wherever the specification varies or conflicts with the drawings, the plumber is to be governed by the specification.

The plumber is to obtain all official permits required, pay the fees for same, and is to give to the proper authorities all notices required by law relating to his work.

All work must conform with the local building and health regulations, and the latter are to be considered a part of the specification.

The plumber must see to it that no damage is done to any part of his own or other contractors' work on the building. He will be held responsible for all soiling of walls, wainscots, finger marks or other defacements by his workmen. He will see that proper care is taken in kindling fires in the plumber's furnace, and in handling the latter anywhere in the building.*

The plumber must see to it that all building rubbish caused by his operations be removed from time to time from the building as may be required. At the

* A good clause to insert is the following: "No smoking or spitting allowed in building after the plastering is done, the trim set and floors laid"

completion of the work he is to deliver everything in a clean condition and in good working order and perfect in all respects.

The contractor will be paid only on certificates properly signed by the superintendent.

[Here should follow a schedule of the fixtures required in the building.]

2. Materials.

All the materials used in the work to be of the best quality obtainable in the market.

Earthenware Drain Pipes.

Outside drains (beginning at a distance of at least five feet from the house) to be of strong, salt-glazed earthen pipes, either pipes provided with hubs at one end, or else plain cylindrical pipes with loose rings or collars of unglazed earthenware.

All vitrified pipe to be perfectly straight, circular and true in section, of

a uniform thickness of not less than three-quarter inch for four and six-inch pipes, to be free from cracks, flaws, or other defects, to be hard-burnt, not brittle, smooth and impervious on the inside and highly glazed, except at the pipe ends. Hubs of vitrified socket pipes to be not less than three inches deep.

Earthenware special fittings, such as T and Y branches, bends, offsets, traps, etc., to be of the same quality and character as specified for pipes.

Cast-iron Drain, Soil and Waste Pipes and Fittings.

Cast-iron drain, soil and waste pipes to be of a homogeneous texture, free from flaws, cracks, sand-holes or similar defects, perfectly straight, truly cylindrical, perfectly smooth on the inside and of a uniform thickness of not less than one-quarter inch. Pipes to be either ordinary bell and spigot joints, with hubs of great depth and strength of metal, or else to be the adjustable flange joint pipe.

Pipes to be tested and inspected at foundry, and to be afterwards coated and protected inside and outside with coal tar pitch or other equivalent substance. Or else pipes to be enameled with black enamel, or to be porcelain-lined (white enamel), as the detailed specifications may require. The superintendent may instead require that the pipes and fittings be tested in his presence by the oil or kerosene test.

All fittings for cast-iron soil and waste pipes to be of best quality cast-iron; all castings to be sound, clean, smooth, true, free from flaws, cracks, sand-holes, air bubbles or other imperfections or impurities in the metal. Thickness of shell to be not less than one-quarter inch. Fittings for bell and spigot pipes to have hubs which must be very deep and extra strong. Fittings for adjustable flange joint pipes to have proper flanges for joining iron or lead pipes. All fittings to be tar-coated or enameled, to correspond with the kind of pipe required by the detailed specifications.

Cast-iron soil pipes to be four inches inside diameter, iron waste pipes to be two inches diameter, drain pipes to be from two to six inches diameter, as called for in detailed specifications, and as indicated on the plans.

Lead Pipes.

All lead pipes to be drawn pipes of soft pure lead, of the best make. Pipes to be either plain or tin-lined, as may be directed in detailed specification.

Weight of lead pipe to be as follows:

a. Supply Pipes.

Inside Diameter.	⅜″	½″	⅝″	¾″	1″	1¼″	1½″
	Lbs. per running ft.						
For street or tank pressure not exceeding 20 lbs. per square inch.....	1	1¾	2½	3	4	5	6½
For street or tank pressure exceeding 20 lbs. per sq. in., and not exceeding 35 lbs. per square inch.....	1½	2	3	4	4¾	6	8
For pressures exceeding 35 lbs. per square inch.....	2	3	4	5	6	7	9

b. Waste, vent, overflow and drip pipes, also supply pipes from w. cl. cisterns to w. cl. bowls.

$\frac{1}{2}$	inch	lead	pipe	to weigh	1	lb. per running ft.
$\frac{3}{4}$	"	"	"	$1\frac{3}{4}$	"	"
1	"	"	"	2	"	"
$1\frac{1}{4}$	"	"	"	$2\frac{1}{2}$	"	"
$1\frac{1}{2}$	"	"	"	$3\frac{1}{2}$	"	"
2	"	"	"	$5\frac{1}{2}$	"	"
3	"	"	"	6	"	"

Block Tin Pipes.

Suction pipes in wells or cisterns to be of pure block tin, to weigh as follows:

				Lbs. per running foot.
$\frac{3}{4}$	inch	block tin	pipe to weigh	$\frac{3}{4}$
1	"	"	"	1
$1\frac{1}{4}$	"	"	"	$1\frac{1}{4}$
$1\frac{1}{2}$	"	"	"	$1\frac{1}{2}$

Brass Pipes.

All brass piping to be made of seamless drawn brass tubing, with all the necessary brass fittings required. Pipes to be either plain (for hot water) or lined inside with tin (for cold water). Outside of pipes to be nickel-plated and polished, or else, if brass finished, pipes to be varnished with a good coat of shellac, as may be required in detailed specifications.

Wrought-iron Pipes.

a. Supply Pipes to be either plain, galvanized, enameled, lined inside with block tin, or rubber lined, or made rustless by the Bower-Barff process, as may be directed in the detailed specifications. Pipes to be uniform and true in section and pipes of sizes up to 1¼ inches to be butt-welded and warranted to be tested by hydraulic pressure of 300 pounds per square inch. All necessary fittings used to have the same protecting treatment as the pipes. All fittings to be malleable iron fittings.

b. Soil, Waste and Vent Pipes to be of standard wrought-iron pipe, having a uniform thickness of not less than one-quarter inch; pipes to be lap-welded and proved at the iron mills to 500 pounds per square inch by hydraulic pressure; to be coated, after being heated, with a preparation of coal tar and asphalt (or to be treated with the Bower-Barff or other rustless process). Fittings for soil and waste pipes to be protected against rust by the same process

as applied to the pipes; to be tapped truly straight and to have a strong shoulder.

Traps.

Traps to be of lead, brass, copper or glass, for sinks, basins and tubs, and to be of iron, lead, stoneware or earthenware under water closets (as may be specified in describing the water closet apparatus).

Traps of lead not to be lighter in weight and thickness of lead than the waste pipes to which they are attached. Drawn lead traps to be preferred to cast lead traps; the latter, if used, to be proved free from sand-holes, flaws or other imperfections. Traps for water closets to have at least one inch, and—except in the case of certain special water closet constructions—not more than two inches water seal. All other traps for fixtures to have at least one and one-half inches effective seal.

All traps to be self-cleansing and free from corners or spaces favoring accumulation of filth, and of such shape as to

hold as little volume of water as is consistent with a proper water seal.

Traps under fixtures to be provided with cleansing trap screws, placed below the water level in the traps, and arranged so as to be accessible.

No bell or D-trap or cesspool trap to be used anywhere (special kind of trap required to be stated in the detailed specification).

Traps for house drains, leaders, yard and area drains to be of heavy cast-iron provided with proper cleaning hand-holes and to have a proper depth of seal of not less than two inches.

Stop-cocks, Valves and Faucets.

Roundway stop-cocks to be used on main lines of service pipes and to be of the same inner diameter as their respective pipes. If supply pipes are of wrought-iron, brass water valves instead of stop-cocks to be used. All valves, faucets and stop-cocks to be of superior gun metal of the heaviest existing patterns.

Plated Ware.

Whenever brass is to be plated the nickel or silver plating (as specified in detailed specification) to be of the best kind, and warranted for at least five years.

Solder.

All solder used in the work to be pure, soft, and free from impurities such as zinc or other admixture.

Pig Lead.

Lead for caulking purposes to be soft and pure pig lead, to be free from any admixture of antimony, zinc or other metal. No lead used for caulking soil pipes to be brittle or hard; no scrap lead to be used.

Sheet Lead.

To be of soft and pure pig lead, rolled in sheets, free from any admixture of alloys or old scrap lead. Weight to be not less than four pounds per square foot.

Sheet Copper.

All sheet copper to weigh sixteen ounces per square foot unless greater weight is called for in detailed specifications, and to be well planished and tinned.

Putty.

The use of putty to be avoided, but, wherever needed, putty to be made up with pure linseed oil, and to be mixed with some red lead, to avoid its being eaten by rats.

Marble.

All marble is to be of best Italian quality, blue veined and highly polished, unless other marble is especially called for in the description of the plumbing fixtures. All slabs are to be properly molded and countersunk. All marble work to be sharply molded and well fitted and set, and where necessary, to be secured with round-head brass screws and washers, the latter sunk in flush.

Fixtures.

All fixtures and apparatus to be strictly of the kind and character and special make as called for in the following detailed description, and every fixture to be free from any defects, perfect throughout, and put in complete working order.

[Here should follow a complete description of the special appliances wanted under the head of

Hydrant; sillcock; furnace or steam boiler supply.

Temporary cock in cellar to furnish water for building purposes.

Double-acting force pump; pumping engine.

Water tank.

Kitchen range; kitchen boiler; kitchen sink.

Cistern pump.

Wash trays; laundry sink; laundry range; clothes boiler.

Refrigerator; ice sink.

Water closets.

Washbasins.

Bath tubs, foot baths, sitz baths, bidets, shower baths, needle baths.
Slop hopper; housemaid's sink.
Urinal.]

Cement.

Hydraulic cement to be any good, pure, quick-setting brand, to be fine and freshly ground; cement to be subject to inspection and testing by the superintendent, who may reject all cement of improper quality.

Sand.

To be clean, sharp, silicious sand, free from all dirt, dust, loam or other foreign matter.

Mortar.

Sand and cement to be mixed dry and to be wetted up only in small quantities as used, and with just enough water to make a paste of proper consistency. Mortar to consist of one part hydraulic cement and two parts of sand—measured quantities. No lime to be used in the

mixture, nor should any mortar be used that has begun to set.

Concrete.

Concrete for foundations and trench bottoms to be composed of one part mortar and five parts broken stone. The mortar to be made up as directed above, with sufficient water only to constitute a fair paste. The broken stones shall then be wetted up and mixed with the paste in a thorough manner by several turnings with a shovel. The concrete, after being thrown in place, to be tamped with wooden rammers. No concrete left over at the close of a day to be used afterwards on the work.

3. Workmanship.

Earthenware Drain Pipes.

If plain cylindrical pipes are specified, joints to be made by means of loose collars or rings, set in mortar. Drain pipes to be laid at a depth of generally not less than three feet, in a carefully exca-

vated trench. Trench to be opened only as wide as necessary, and to be suitably braced wherever required, to prevent any caving in of the sides. Trenches to have bottom trimmed perfectly to the exact grade, and to have at each pipe joint a depression in order to have each length of pipe evenly and perfectly supported. Pipes should be laid with ends butting close together. Cement mortar, mixed as per directions given, to be applied to the unglazed ends of the pipes and also to the inside of collars. Pipes to be joined in such a manner that the flow line will be true and even, in order to prevent stoppages. The inside of each length of pipe to be well cleaned before laying down the next length. Drains to be laid in perfectly straight lines, and deviations from alignment to be made with special curves of large radius. Each length of pipe to be covered in the center with a few inches of earth, in order to steady it and to prevent any pipes from moving. After testing pipe joints with water the back filling to

be done with great care in order not to disturb the pipes. Earth to be thrown in in layers of not more than twelve inches in depth, and the filling to be well rammed or puddled, to prevent the slightest settling. All outside branch drains to join the main by Y, not T branches. Bends in the lines of the drains should never be made with straight pipes. Pipes of different sizes to be joined by proper reducing fittings. Long lines of house drains to have man-holes or inspection holes placed at suitable intervals.

If earthen socket pipes are specified, sockets to be examined with special care for cracks or flaws, before lowering pipes into the trench. Trench to be excavated as described heretofore. Special grooves to be cut in the bottom of the trench for the sockets, in order to give to the pipes a firm bearing throughout their entire length. Pipes to be laid with the socket pointing up grade. The space between spigot and hub, if the hub is deep, to be filled first with a small gasket of

oakum, to prevent any cement mortar from entering at the joints. The remaining space to be filled with hydraulic mortar, which must be applied with particular care at the bottom of the joint. Water accumulating in the hollow grooves must be removed before applying mortar to the joint. Some cement to be wiped at the face of each joint, and as soon as the joint is finished, the grooves to be filled with earth, in order to support the cement at the joint until the cement has had time to harden. The utmost care to be observed after a joint is made, to prevent any disturbance of the pipes by stepping on them, or otherwise. The inside of each pipe joint to be thoroughly cleaned from any projecting oakum or cement. Back filling to be done as described heretofore.

Earthen pipes must always be laid on a firm bed, which should be provided in case of loose soils. A bed of gravel or sand or a concrete foundation should be prepared in such cases to properly support the pipes.

Joints between earthen pipes and iron house drains to be made perfectly tight by means of pure hydraulic cement.

Cast-iron Pipes.

All joints in cast-iron socket pipe and fittings to be made by inserting a gasket of picked oakum into the space between spigot and hub, so as to fill about one-half of the depth of hub, and pouring molten soft lead from a large ladle into the remaining space. After cooling and shrinking, the lead to be thoroughly caulked with caulking tools to insure air and water-tight joints. The face of the caulking lead to remain without paint, putty or cement, so as to leave the marks of the caulking tool exposed to view. All joints made before soil pipe and fittings are put in place must be recaulked when the soil or waste pipe stack is up, as they may otherwise become loose from jars.

Adjustable flanged joints in cast-iron pipe to be made by inserting between pipe ends or between end of pipe and

of fitting, a lead washer or gasket for packing, which is to be crushed between the flanges which are connected by means of bolts and nuts of proper strength. To screw the nuts up evenly, two ratchet wrenches should be worked simultaneously.

Iron pipe lengths in a vertical position to be firmly held in place by strong iron hooks, or better, to be supported by strong pipe rests or supports, well fastened to the walls, and placed under each hub. Where hung from the ceiling, pipes to be held in place by iron pipe hangers, securely fastened to joists, or, best of all, supported at suitable intervals by brick piers.

Suitable provision to be made, especially in very high buildings, for the free contraction and expansion of each vertical stack by fastening the pipes in such a manner that a slight movement parallel to the pipe axis may take place, especially where a waste pipe receives much hot water.

All changes in direction to be made

with bends of large radius, and all branches to be Y or half Y branches, or curved Tees (the latter only on upright lines).

After all pipes are put in place they are to be cleaned and painted so as to look neat at the completion of the work.

Lead Supply and Waste Pipes.

All joints between lead pipes, whether for supply or waste pipes, to be wiped solder joints; cup joints not to be made anywhere.

Joints between lead pipe and brass fittings, such as stop-cocks, ferrules, etc., to be wiped solder joints; joints between lead pipe and brass couplings may be cup joints.

Joints between lead pipe and cast-iron pipe or hub fittings, to be made by means of a brass or copper ferrule, soldered to the lead pipe and tightly caulked into the iron hub.

Joints between lead pipes and flange joint iron pipes to be made without brass ferrules, by simply flanging the

lead out, using a lead packing ring between the lead and iron flanges, and bolting to the latter a cast-iron ring, having ears and bolt holes to correspond with those of the pipe flange.

Joints between lead pipe and wrought-iron pipe or tapped fittings to be made by means of brass male or female soldering nipples, wiped to the lead pipe, and tightly screwed with a wrench into or onto the tapped fitting or threaded pipe.

Connections between earthenware and lead to be made, as much as possible, by means of brass couplings.

All vertical lead pipes to be supported by hard metal tacks, placed at short and equal distances, and securely fastened by screws to boards put up by the carpenter.

Horizontal or graded lead pipes to be firmly supported throughout their whole length on boards to prevent sagging and trapping, and to be fastened and kept in place by brass bands (strips of sheet brass bent to conform to the shape of the pipe) placed at frequent intervals

and fastened to the boards by screws. Hot-water pipes to be fastened, preferably by brass bands only, not by tacks, so as to allow for necessary expansion and contraction. Hooks should never be used in fastening lead pipes.

Joints in tin-lined lead pipes to be made by means of the special tinned brass ferrules and fittings furnished with the pipe by its manufacturers. If wiped solder joints are made, unusual care is required, so that, in applying the heated solder, the tin may not be melted and thus the pipe lining destroyed.

Wrought-iron Pipes.

Joints in wrought-iron pipes to be made with screw threads cut on the ends of the pipes and in the shoulder of fittings. All threads to be of standard gauge. All cut ends of pipe to have the burr removed. A thick paste of red and white lead mixed, or else linseed oil, to be used in the joints to act as lubricant, and to make up for imperfections in the threads. Pipes to be screwed together

tightly with wrenches or pipe tongs, care being taken that no lead is squeezed out at the inside of pipes. In putting together wrought-iron pipes and fittings treated with black enamel, a liquid black enamel should be used at the joints, to protect the threads against rust.

Wrought-iron pipes, lined inside with tin, should be joined by means of the special ferrules sold for such purpose with the pipe.

Horizontal wrought-iron pipes to be supported by means of special pipe hangers. All exposed vertical lines of iron supply pipes are to be carried perfectly plumb and straight at an even distance from the walls, and secured with galvanized iron or brass holdfasts, arranged so that they can be readily removed.

Brass Pipes.

All brass pipes and brass fittings to be put together with screw joints, a paste of red lead being put over the threads, and the joints made perfectly tight by

means of screw wrenches. Brass pipes to be put up on boards and fastened by brass bands, holdfasts and escutcheons, or to be supported by neat brass hangers, varnished or nickel-plated. No hooks to be used. Long horizontal lines of brass service pipes for hot water should not be confined at ends, but should be arranged so as to allow of free expansion and contraction.

Stop-cocks and Faucets.

Joints between bibbs or stop-cocks and lead pipes to be wiped solder joints; those between bibbs or stop-cocks and wrought-iron or brass pipes to be screw joints.

Traps.

All joints between lead traps and lead waste pipes to be wiped solder joints, made perfectly tight. Joints between lead traps and cast-iron soil pipe or fittings to be made with brass ferrules, soldered to the lead pipe and caulked into iron hubs. Junctions between trap

and waste pipe to be made perfectly tight with the greatest care. Junction between fixture and trap may be made movable, to facilitate repairs of the fixture.

Water closets having traps located above the floor must have joints at the floor with the soil pipe made with particular care, so as to be thoroughly tight.

Water closet traps of iron or lead below the floor must have their weight well supported, to prevent the joint at the floor from being torn loose and becoming leaky.

Traps under fixtures, leader traps and the trap on the main drain must be set perfectly true as regards their water level. All bending or tipping of lead traps must be avoided. In all cases traps are to be placed as close to fixtures as possible.

Fixtures.

Workmanship in fixtures to be of neat appearance throughout, whether work is to remain exposed or not. All fixtures, with the appliances belonging to them,

to be properly set in good and complete working order.

In General.

All plumbing work, whether to be left exposed to view or to be boxed up, to be done in a thorough manner.

Putty joints to be avoided wherever feasible.

All openings into the pipe system, as well as fixtures set in place, must be securely covered up, to prevent obstruction of the pipes or breakage of fixtures by carelessly or maliciously dropped materials.

The plumber must cut no beams, joists, floors or studs; this will be done for him by the carpenter. Plumber is to arrange all pipes between joists so as to run, wherever possible, parallel to the direction of the beams. Pipes placed between joists to be run with proper grade, and to be continuously supported on sound boards, nailed over strips tacked to the joists.

Where pipes pass through the roof, an

absolutely water-tight joint to be made around pipes. If flsshings are used for this purpose, they should be at least eighteen inches square, of heavy sheet lead or copper, with a funnel slipped over the pipe, turned over and caulked into a hub, while the ends of the flashing are tightly fastened to the roof.

Wherever plumbers' pipes pass through floors, ceilings, walls or partitions, the plumber must see to it that the holes are neatly and perfectly closed around the pipes in the floor, and that the hole in the ceiling be closed up and well plastered. If required, sleeves of galvanized iron pipe are to be used in the case of supply pipes with neatly-fitted polished and lacquered or nickel-plated brass escutcheons, screwed on at the floor and ceiling, or either side of the walls, as the case may be.

4. General Arrangement of Plumbing Work.

The whole work to be arranged and executed in strict conformance with the

specifications and the floor plans and sections, showing the plumbing work, and in particular the *exact location* of every plumbing fixture in the building. Unless special permission is obtained from the superintendent to deviate from the lines as laid out in the drawings, these must be strictly followed.

[Here insert a detailed description of the course of all soil and waste pipes, vent and supply pipes.]

Soil and Waste Pipes.

All main lines of drain, soil, waste and air pipes inside of the building to be of iron; short branch wastes and vents from fixtures and traps, and branch supply pipes to be of heavy lead pipe.

All soil and waste pipes and supply pipes to be placed where shown on plans, and their whole arrangement to be as compact and direct as possible.

Each vertical stack of soil or waste pipe to run as straight as possible, avoiding offsets, up to the roof, and to be continued to a point at least three feet

above the same, so as to have the mouth well exposed to air currents. Extensions above the roof to be at least full size in the case of all soil pipes; it is preferable, however, to enlarge soil pipes to six inches above the roof, and waste pipes should be enlarged to four inches before passing through the roof. None of the pipes above the roof should be smaller than four inches, because smaller openings are liable to clog and freeze up in winter time.

Mouths of all soil, vent and waste pipes to be kept at a safe distance from ventilating shafts, dormer windows, skylights or chimney flues. Vertical pipes run along chimney flues to terminate at least two feet below the top of the flue.

Mouths of all pipes above the roof to be kept *wide open.* No return bend, ventilating cap or patent ventilator to be used. Where obstructions are anticipated, carry the pipe at least six feet high, and where this is impracticable, cover the mouth of the pipe with wire gauze, or insert a mushroom-shaped wire basket.

No soil or vent pipe to be run to and to terminate in any hot or cold flue or ventilating shaft.

Soil pipes receiving wastes from water closets to be four inches in diameter, all other waste pipes to be two inches. No deviation to be made from these sizes unless ordered or approved by the superintendent. Each soil and waste pipe stack to have proper fittings to receive branch wastes from fixtures.

No soil, waste or vent pipe to be connected with any chimney flue. No soil or waste pipe to be used to carry rain water. No trap to be placed at the foot of any vertical stack of soil or waste pipe.

Junction between Vertical Pipes and Main Drain.

Junction between vertical stacks of soil or waste pipe and main drain to be made with Y branches and eighth bends, or, at the upper end, with bends of easy sweep. Junctions to be supported by strong brick piers.

Main Drain.

Main drain in cellar to be kept above the floor, *in sight*, unless otherwise directed by the superintendent. Size of main drain to be not less than four nor more than six inches in diameter, unless specially ordered by the superintendent.

Grade of pipes in cellar or basement to be not less than one-quarter of an inch nor more than one inch to the foot, unless by special approval of the superintendent. All branches to join the main with Y-branches pointing in the direction of the flow.

Cleaning Hand-holes.

Cleaning hand-holes (closed by trap screws) to be provided near all junctions between vertical and horizontal pipes, and at junctions of horizontal branch pipes with the main drain, also near bends and traps.

Trap on Main Drain.

Main drain to be trapped (unless the trap is to be omitted by special order of

the superintendent, in which case the fresh air inlet can be dispensed with) where it leaves the house walls by a running or by a ½ S-trap of iron, with proper cleaning hand-holes, arranged accessible, but not exposed to freezing. Over the main trap and all other cleaning hand-holes, if below the cellar floor, arrange cast-iron frames, set in masonry or cement, and having chequered iron covers.

Fresh-air Inlet.

From just inside the trap run a 4-inch fresh-air inlet, terminating at a point above the surface, well remote from windows, and with opening protected against obstructions. (The superintendent will decide exact location of the fresh-air inlet.)

Leader Pipes.

Vertical pipes for the removal of rain water from roofs, placed inside of the building, must be of cast-iron or wrought-iron, with tight joints. No waste water

from any plumbing fixture to deliver into any leader pipe.

Trapping of Leaders.

Outside leaders of metal (galvanized iron, copper, tin), with slip or soldered joints, and also leader pipes of whatever material, whether located inside or outside the building, must be trapped in case the top opens below or near windows, or near flues or ventilating shafts. Iron leaders with tight joints, with tops remote from windows, not to be trapped.

Traps for leaders to have a seal of more than ordinary depth, to provide against evaporation. Traps for leaders and those for yard and area drains not to be buried out of sight or covered with concrete, but to be in all cases placed where they are protected against the action of frost, in easily accessible positions, and to be provided with cleaning and inspection hand-holes, with well-fitting and tight-closing covers.

Drainage of Areas and Yards.

Areas, court yards and paved open

spaces to be properly drained by trapped branch drains, the trap to be located preferably inside the cellar wall, protected against freezing. Openings in the yard or area to be covered with well-fastened brass strainers or iron gratings, protected against rust. No bell traps to be used.

Waste Pipes for Fixtures.

Each fixture to have a separate and independent connection to the main soil pipe (unless otherwise approved by the superintendent). In no case shall basin or bath tub wastes discharge into a water closet trap below the floor.

Branch wastes from fixtures to be carried as directly as possible to the soil or waste pipe. Branch waste pipes carried under floors to be as short as practicable, and to have a continuous support, to prevent sagging.

Trapping of Fixtures.

Each fixture connected to the soil or waste-pipe system to be provided, as

near as possible to its outlet, with a suitable trap, secure against siphonage, back pressure, evaporation, etc. [The kind of trap should be specified in the detailed description of each apparatus.]

No fixture to be provided with more than one trap. No trap under a fixture to be of larger bore than the waste pipe to which it is attached.

All traps under fixtures to be arranged so as to be readily accessible, and to be provided with cleaning hand-holes or trap-screws, located below the water-line of the trap.

Round pipe traps of the S, half S, or running shape, not to be used unless provided with a ventilating pipe, or some other effective attachment, to prevent siphonage.

Trap Vent Pipes.

Wherever vent pipes are used, those for water-closet traps should be not less than two inches in diameter. All other traps to have vents of same area as the trap. The size of the main vertical lines

of vent pipe will depend upon the height of the building and should increase with the number of branches which it receives.

If back air pipes are carried through the roof, they must be enlarged to four inches to prevent clogging in winter time in cold climates. All horizontal air pipes must be so graded as to discharge the water from condensation into a trap or waste pipe.

Size of Waste Pipes.

Waste pipes for fixtures to be in size as follows:

	Inches inside diameter.
For wash bowls	1¼
For bath tubs	1½
For pantry sinks	1½
For kitchen sinks	1½
For laundry tubs	1½
For slop sinks	2
For urinals	1½
For a row of basins, tubs or urinals	2

No deviation from these sizes permitted unless specially ordered by the superintendent. The weight of these pipes to be such as called for under "Materials."

Overflow Pipes.

Overflow pipes from fixtures must connect with waste pipes on the inlet side of traps, or they must enter the trap below the water line. They should be entirely avoided wherever possible, and hence fixtures without hidden overflow pipes are much to be preferred.

Strainers.

Outlets of all set fixtures, except water closets, to have fixed strainers, to guard against obstructions.

Safes and Drip Pipes.

All safes, where required under fixtures, to be of 4-lb. sheet lead, with edges turned up at least two inches all around; to have a convex brass strainer, well soldered, and a 1-inch drip pipe of lead or rustless wrought-iron pipe carried to a point where a discharge from leakage or otherwise is readily detected. If run to cellar ceiling, arrangements to be provided to exclude cellar air from the drip pipe. The drip pipe may empty

over a sink or cistern, but always so that the discharge may be in sight. In no case should drip pipes be connected with a soil or waste pipe.

In most cases safes and drip pipes may safely be omitted if the work is well done, and all fixtures set in an open manner.

Flushing Cisterns.

Each water closet, urinal or slop hopper should be supplied with water from a special flushing cistern. The pipe, from cistern to the fixture, must never be less than 1¼ inches in diameter and should be run from the cistern to the bowl as directly and straight as possible.

Refrigerator Wastes.

Waste pipes from refrigerators or ice-chests to be trapped, and not to have a direct connection with any drain, soil or waste pipe.

Tank Overflow.

Overflow pipes from tanks must not discharge into any soil, drain or waste

pipe. They may be run into the roof gutter, or else discharge over a sink in the basement, or be carried and emptied into the nearest fixture where the discharge will be visible.

Open Arrangement of Fixtures and Pipes.

All fixtures to be arranged in an open manner, unless otherwise directed by the superintendent.

All soil, waste, vent, supply or drip pipes to be kept exposed to view, or to be cased in wood, fastened with screws so that they may be readily accessible. All piping to be kept outside of partitions, unless otherwise ordered by the superintendent. No pipes to run between floors and ceilings unless *absolutely* necessary.

All spaces about soil, waste or supply pipes, where these pass through floors and ceilings, to be closed absolutely tight in a neat and substantial manner.

Arrangement of Supply Pipes.

The whole arrangement of supply pipes to be as compact as possible.

All supply pipes to be kept outside of floors, walls and partitions, being left exposed and in full view, unless specially otherwise directed by the superintendent. All exposed iron pipes are to be neatly bronzed, if required, with silver or gold bronze, and varnished.

No water supply pipes to run on outside walls, nor to be placed in any position where they would be liable to freeze, unless absolutely necessary, and in this case pipes to be securely protected in exposed places by some non-conducting material, as may be required by the superintendent.

All horizontal lines of supply pipes to be arranged neatly, and laid out so that they will not cross each other or dip one under the other. Supply pipes not to have any depressions or sags, nor to be bent up in their course to avoid their becoming air bound, and causing an interruption in the circulation in the case of hot water pipes.

All supply pipes to be so graded and

arranged that they may be easily and completely emptied.

No check valves to be used on any supply pipes unless specially called for in the specifications.

Hot and cold water pipes to be kept at least one half inch apart everywhere.

To prevent injury to decorated walls or ceilings from drippings arising from condensation in warm weather along cold water pipes, especially if of iron, pipes should be carried across floors in safes made of zinc, and provided with a drip pipe run to cellar.

Size of Supply Pipes.

Branch supply pipes to fixtures to have the following sizes, unless otherwise directed:

For wash bowls	½ inch bore.
For bath tubs	½ "
For pantry sinks	½ "
For kitchen sinks	½ "
For laundry tubs	½ "
For slop hoppers (to draw water)	½ "
For flushing cisterns	½ "
For flushing pipes from cisterns to water closets, urinals or slop hoppers	1¼–1½ "

For weight of pipes, see under "Material."

Rising main to be at least ¾ inch in size; direct branches from it to be of the same size, and pipe from tank to boiler to be not less than ¾-inch. Connections between water back in range and boiler to be made with ¾-inch (better 1-inch) brass or stout brazed copper pipes.

H W ater Supply.

Hot water boilers always to be supplied from a tank in the attic, not from street pressure. Main hot water pipe must always be extended from above the highest fixture full size to the top of the tank, where it should be turned over to allow steam to escape; also to prevent the collapse of the boiler.

Stop-cocks.

Stop-cocks for both the hot and cold water supply to be arranged near each fixture (also near each flushing cistern), to shut off the water separately from each fixture if required.

All branch supply pipes to be arranged so as to be shut off separately by stop-

cocks or valves, and, if required, to be arranged so that they may, each separately, be completely drained.

All stop-cocks on supply pipes to be arranged easy of access.

Faucets, especially ground-key and self-closing bibbs, not to be placed at the end of a line of supply pipe, but to be taken from the side of the pipe, and the pipe to be continued so as to form a small air chamber.

5. Tests of the Work during Construction and after Completion.

Test of Earthen House Sewer.

Before refilling the trenches for outside drains the earthen sewer pipe and its joints to be tested by closing the main outlet and filling the sewer with water so as to have a pressure corresponding to at least two feet head of water at its upper end, and all joints to be proven tight to the satisfaction of the superintendent.

Test of Pipe System inside the House.

After the completion of all the piping in the house and before any fixtures are connected, the tightness of joints and soundness of pipes to be tested. All openings of waste, soil and vent pipes and the outer end of house sewer to be securely closed, and the whole system of piping to be filled with water, which must remain at the same level for at least 12 hours. In winter time other tests—smoke test, peppermint or fumes of sulphur test, pressure test with force pump and manometer—to be substituted for the water pressure test. If any of these tests reveal a leak the defect is to be made good, and pipes will again be tested until the system is proved gas and water-tight to the satisfaction of the superintendent.

Test of Supply Pipes.

All iron and brass supply pipes are to be tested with pressure pump and mercury gauge, and all defective pipes and

fittings removed and replaced by sound material and all leaky joints made tight.

Final Test of the Completed Work.

The whole plumbing work is to be tested after completion by turning the water into the pipes, fixtures and traps everywhere, in order to detect imperfect joints or bad pipes, or holes caused by careless driving of nails.

The whole system is, finally, to be tested in the presence of the superintendent by the oil of peppermint test, or fumes of burning sulphur, introduced by means of an "asphyxiator." Any defects found to be at once repaired by the plumber, who is to bear the whole expense, and all to be left in perfect working order and warranted for —— years.

C. Rules regarding the proper Care and Management of Plumbing Apparatus.

Even the best sanitary appliances discharging quickly through self-cleansing traps and well-ventilated and abundantl

flushed waste pipes need constant care and frequent cleaning.

Plumbing fixtures, and all traps, soil, drain and waste pipes, require periodical inspection, same as a steam boiler or other machinery. In order to be readily inspected, they must be kept accessible. Therefore avoid all enclosure of the plumbing work.

The whole security of plumbing work lies in thorough workmanship, good materials, safe trapping, abundant flushing, constant ventilation and *absolute purity*.

The water in traps under any kind of plumbing fixture must be frequently changed.

Stagnation of water or air should be avoided, not only in the drains and vent pipes, but in traps as well.

A judicious use of the fixtures and proper cleanliness are indispensable to keep plumbing apparatus in a sweet and wholesome condition.

Water closets and slop hoppers in particular, but other plumbing fixtures not to any less extent, should be thoroughly

cleaned and scrubbed with soap, hot water and a scrubbing brush, at least once a week, and as much oftener as possible.

The same care and treatment should be applied to the floors and walls surrounding the closet, and to the woodwork of the seat. Hence it is important, in order to facilitate cleaning operations, to arrange all plumbing work in an open manner.

Even where fixtures are cased up with ornamental woodwork, let the parts be readily removable; avoid nailed carpentry, and never allow any accumulation of rags or rubbish of any kind under the water closets, basins or sinks.

After cleansing the sides of bath and laundry tubs and wash basins, let clean water from the faucets run for some time into the fixtures, in order to change completely the water standing in the trap.

After pouring out slop jars or pails into slop hoppers, always flush the fixture and its trap by one or more discharges from the flushing cistern.

If you have plumbing work in spare

rooms, closets or guests' bedrooms, let some one of the household make it a daily practice to turn on the water, to make sure that the traps are constantly filled.

If much grease is emptied through kitchen or pantry sinks, it is advisable to rinse occasionally the waste pipes and traps by pouring through them a hot and concentrated solution of potash.

In leaving a city house for the summer months, when evaporation of water in traps is most active, *especially with vented traps*, all overflow holes in wash bowls, pantry sinks and bath tubs should be closed by corks or by pasting paper over the openings, then close the outlets with plugs and fill basins and tubs with water to near the overflow line. In the case of kitchen sinks it is best to remove the open strainer, substituting a plug strainer, closing the outlet with a plug and filling the sink with water. Wash tubs may be similarly protected by closing the outlets and filling the tubs with water. Fixtures without overflow pipes

(with stand pipe outlets) are more easily protected than those in common use, and are preferable on this as well as on many other accounts. In case of slop hoppers and water closets, it becomes necessary to dip out all water from the trap and to fill the trap with glycerine or oil, or a solution of chloride of calcium. Water closets and slop hoppers flushed from automatic siphon or tilting tanks may continue to receive the flush at intervals, provided their branch supply pipe is taken out in such a manner that it will not interfere with the shutting off of the water in the remaining parts of the house. Trap attachments may also be had which continue to keep the trap filled with water up to the proper water level, if evaporation or loss by siphonage or capillary attraction should take place.

In leaving a country residence for the winter, it is of the utmost importance to remove completely all water from all supply and waste pipes, traps, fixtures and cisterns so that nothing can freeze. Hence it is very necessary in the case of

country houses to run all pipes with such a continuous grade that they may be completely drained and emptied. The water supply should be thoroughly shut off in the basement or cellar, taking care to open all faucets and stop-cocks at fixtures. The kitchen boiler must be completely emptied by means of the sediment cock, and also the water tank in the attic. Next remove the water from all water closet and slop hopper cisterns. Traps under fixtures may be emptied by means of the brass trap screws usually provided, at the lowest point of the trap, or by removing the cleanout caps, or else by using a sponge. All overflows must be closed, the traps filled with glycerine, and the outlets of fixtures closed with plugs as previously described. Water closet traps should be filled with a strong salt solution, to which may be added some calcium chloride. As an additional security the trap may be boxed up, and the box filled with sawdust.

III.

SUGGESTIONS

FOR A

SANITARY CODE.

SUGGESTIONS FOR A SANITARY CODE.

A.—Rules as to Healthful Building Construction.

1. It shall be considered unlawful hereafter to erect or cause to be erected a new building upon any site which has been filled up with house refuse or any kind of animal or vegetable matter, unless such matter shall have been properly removed from such site.

2 It shall be considered unlawful hereafter to erect or cause to be erected any new buildings or structures of any kind upon any damp or wet site, unless such site shall have been effectually drained by means of suitable properly laid earthenware tile pipes.

3. It shall be considered unlawful to lay such drain pipes in such a manner as to communicate directly with any drain carrying foul sewage, or with a sewer or cesspool.

4. The drainage of the subsoil of buildings shall conform to the following regulations and requirements:

a. The subsoil drains shall be laid, if possible, at a depth of not less than two feet below the cellar floor.

b. They shall be laid with open joints, protected against entrance of dirt or vermin by paper or muslin wrapping or collars.

c. They shall be laid on a true grade, with perfect alignment and with a continuous fall towards the outfall.

d. The outfall shall be either directly into the open air, or into a ditch or road gutter.

NOTE.—If connection must necessarily be made with a sewer, arrangements shall be made for perfect disconnection, and the water seal of the trap must be maintained, even in the driest seasons, by suitable arrangements, approved by the inspector.

5. Wherever the building site is damp,

the cellar floor shall be constructed with at least six inches of concrete. It is recommended to put on top of this a thin coating of coal tar pitch or asphalt, and to finish it on top with a layer of Portland cement.

It is recommended that every wall of new buildings be provided with a damp-proof course of proper material, placed above the level of the ground, and also that the outside and inside of the foundation wall to the height of the damp-proof course be coated with coal tar pitch or asphaltum.

It is recommended to whitewash the cellar walls of all buildings at least twice a year.

6. Buildings without basement or cellar shall be placed on brick or stone piers or posts, and the floor of the first story shall be raised so as to be at least two feet above the surface of the ground. There shall be a free circulation of air underneath the floor, and between it and the surface of the ground.

B.—Rules as to Connection between House Drains and Street Sewers.

1. It shall be considered unlawful to connect or cause to be connected, any private drain with a street sewer, without first obtaining a permit from the proper authorities.

2. It shall be considered unlawful hereafter to construct any drain for any building and to connect the same to a street sewer, unless the drain shall in its plan and construction conform to the following requirements:

a. Each building shall have a separate connection with the street sewer.

b. Wherever junction pieces have been built into the sewer they must be used for making said connection, unless special permission is obtained to cut the sewer.

c. No pipe or other materials for drains shall be used until they have been examined and approved by the authorities, or their duly appointed superintendent or inspector. No house drain to be larger than four

inches inside diameter, except by special permission.

d. No street shall be opened until the junction piece in the sewer has been located by the superintendent.

e. If no junction pieces are built into the sewer, a connection shall be made by inserting into a brick sewer a junction pipe of proper size, and cut slant to an angle of forty-five degrees by the manufacturer. Great care must be taken not to injure the sewer, and all rubbish shall be carefully removed from its inside.

f. In connecting a house drain with a pipe sewer, a Y junction must be inserted in the line of the sewer, and the main sewer left in a good condition.

g. In all cases the trench must be opened to the point of connection without tunneling, so as to allow of an easy inspection.

h. In opening any street or public way all materials shall be placed where they will cause the least inconven-

ience to the public, and the whole inclosed with sufficient barriers, and properly lighted at night from the beginning to the end of the work.

i. The least inclination of the house drain shall be 1 in 60, unless a written permit is obtained to lay the house drain to a lesser grade.

k. When the course of the house drain is not the same as that of the junction piece, it must be connected therewith by a curve of not less than ten feet radius. All changes of direction to be made with curved pipe, and in no case must a pipe be clipped.

l. Every joint shall be laid with gasket and cement, and bedded in hydraulic concrete at least four inches in depth.

m. The ends of all pipes not to be immediately connected shall be securely closed, water-tight, and guarded against entrance of earth with imperishable materials. The inside of every drain, after it is laid, must be left smooth and perfectly clean

throughout its entire length, and true in line and grade.

n. The back-filling over drains, after they are laid, shall be puddled or rammed, all water and gas pipes protected from injury or settling, and the surface of the street made good within forty-eight hours after the completion of that part of the drain lying within the public way.

o. No privy vault or cesspool shall be connected with the house drain or sewer.

C.—Plumbing Regulations.

1. No plumbing work of any kind shall hereafter be constructed in any building, nor connection made between a house drain and a street sewer, unless said work shall be made to conform strictly to the following requirements:

a. The house drain may be of glazed vitrified pipe with cemented joints to within five feet of the outer line of the house foundation walls. From

this point to the inside it shall be of cast-iron pipe, at least ¼ inch thick, and with joints well caulked with lead, and made air and water-tight.

b. All lines of soil or waste pipes in a building shall be of iron.

c. The house drain shall be trapped, near the point where it leaves the building, by a running or half S-trap, which shall not be larger in diameter than the house drain. This trap shall be placed in an accessible position, and must be provided with an inspection hole, and a tight closing cover.*

d. The house drain shall not be laid beneath the cellar floor unless ab-

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* This refers to connections with old and improperly constructed, or foul street sewers, and to cases where house drains discharge into a cesspool or flush tank. For well-constructed, self-cleansing sewers, provided with flushing arrangements and ample ventilation, the trap should be omitted. In the latter instance it should be made a law that in every house connected with the street sewer there shall be an uninterrupted flow of air passing from the sewer up the house drain and soil pipe, and out at the roof, or *vice versa*.

solutely necessary, and in this case it shall be laid in a trench and shall be surrounded with concrete. The trench shall be closed after the drain is thoroughly inspected and pronounced perfectly tight.

e. All connections in horizontal pipes to be made with Y branches.

f. There shall be a fresh-air inlet pipe, entering the house drain just inside of the main trap, of a diameter of not less than three inches, and opening at any convenient place out of doors, approved by the superintendent or inspector.*

g. All soil and waste pipes shall be run in as straight a manner as possible up to, and at least three feet above, the main house roof. Soil pipes to be enlarged to six inches and waste pipes to four inches above the roof. The upper terminus shall not be located too near a window, ventilating shaft, or chimney flue; the out-

* When the trap is not required the fresh-air inlet should be omitted.

let above the roof shall not be capped by either a return bend, ventilating cap or movable ventilator.

h. Extensions of soil or waste pipes shall not be constructed of sheet metal or earthenware, and no soil, waste or vent pipe shall stop in any brick or earthen chimney flue, serving as a ventilator.

i. No soil pipe shall be larger than four inches, and no waste pipe larger than two inches inside diameter (their extensions above the roof excepted).

k. Before the fixtures are placed in connection with the pipe system, and before the soil pipe and iron house drain are connected with the outside drain, the outlet of the house drain and of all its branches shall be closed tight and the pipe filled with water to its top, and every joint shall be carefully examined for leakage, and all leaks shall be securely closed before connections are made with said pipe system.

l. All soil and waste pipes shall be kept outside of walls or partitions, and the system arranged in such a manner that it may at all times be readily examined and repaired.

m. Every fixture in the house shall be separately and effectually trapped by a seal-retaining trap placed close to the fixture, and arranged so as to be safe against back pressure, self-siphonage, loss of seal by evaporation or siphonage.

n. No branch waste pipe for tubs, sinks, basins, to be larger than one and one-half inches diameter.

o. Connections of lead pipes with iron hub pipes, shall in all cases be made with brass ferrules, properly soldered to the lead, and well caulked to the iron pipe.

p. Every water closet shall be adequately flushed with water from a special flushing cistern, arranged directly above it, except that where a cistern is liable to freeze, other methods may be permitted, provided that

thorough and sufficient flushing is secured. Every water closet apartment shall have direct means of ventilation into the open air. Pan closets shall not be used in any building. The outlet of water closets shall not be larger than three inches in diameter.

q. No opening shall be provided in the house drain for the purpose of receiving the surface drainage of the cellar, unless special permission is previously obtained.

r. All rain water conductors which are carried up within the walls of a building shall be of iron pipe. Connections with such rain water pipes along their vertical course for the discharge of sewage or waste water therein will not be permitted. Rain water conductors shall be trapped if they open at the top near windows, ventilating shafts or flues.

s. It shall be unlawful to throw or deposit, or cause or permit to be thrown or deposited, in any vessel

or receptacle connected with a public sewer, any garbage, hair, ashes, fruit or vegetables, peelings, or kitchen refuse of any kind, rags, cotton, cinders, or any other matter or thing whatsoever, except fæces, urine, the necessary closet paper, and liquid house slops.

t. Waste pipes from refrigerators or other receptacles, in which provisions are stored, shall not be directly connected with a drain, soil pipe, or other waste pipes, but shall be made to discharge over an open tray, provided with a waste pipe and seal-retaining trap.

u. Drip pipes from safes, under any kind of plumbing fixtures, must not have any connection with any soil, waste or drain pipe.

v. Overflow pipes from water tanks shall not be connected to any soil, waste or drain pipe.

w. No steam exhaust shall be directly connected with any soil or waste pipe, or drain communicating with a street sewer.

IV.

MEMORANDA

ON THE

COST

OF

PLUMBING WORK.

MEMORANDA

ON

THE COST OF PLUMBING WORK.

While this volume was going through the press it occurred to me that a few notes on the cost of work, of such a character as is described in the preceding pages, and as is now required in the best examples of drainage and plumbing of buildings, would be of particular usefulness to architects, their clients, and all people contemplating the remodeling of their plumbing work.

What moves me particularly to publish some memoranda regarding the approximate expense of such work is the fact that there seem still to exist in many quarters very vague ideas on this point. The majority of people who build houses will insist upon having numerous and elaborate plumbing appliances. Generally, however, on receiving bids for the work they

are disagreeably surprised about the "exorbitant" figures asked for. Such people should remember that plumbing and drainage work of the *best* character will cost more than the flimsy, unsanitary work put until recently into most houses, and in particular into those erected by unscrupulous contractors, or by the cheap or speculative builders. It is useless and wrong to make careless statements, such as the following, which I find in a recent architectural publication:

"In an ordinary household, numbering six or eight persons, occupying an average dwelling, there will usually be a single bath room, two water closets, one upstairs, and one for the use of domestics, a kitchen sink and hot water boiler, wash trays, butler's pantry sink, and from one to five stationary wash basins, while if the water pressure is deficient in the city, or if in the country the roof water is stored for family consumption, a tank or cistern will be required. In such a dwelling a four-inch soil pipe will be ample for the drainage from the prin-

cipal fixtures, and a two-inch cast-iron waste pipe from the basins, if any are located at a distance from the main lines. There will also be need for a two-inch waste from the kitchen fixtures, together with a five-inch rain leader, and connections from surface cesspools in the front and back yards. All these pipes will discharge into a five-inch main drain leading to the sewer or cesspool. *To plumb a house of this grade will cost in the neighborhood of three hundred dollars.*" (The italics are mine.)

Such statements are apt to do a great deal of injustice and even harm to respectable plumbing contractors who strive to do work of a high character, and do not expect to make more than a legitimate profit on their contracts. It is absurd to expect the work enumerated in the particular example quoted to be done in a proper manner at such a low figure. *Twice the sum named* would, from my judgment and experience, be a moderate and tolerably correct estimate of cost, and even this would suppose the

work to be of a plain character, although satisfactory from a sanitary point of view.

The figures given below apply to fixtures, completely put up, with their supply and waste pipes, traps, vents, water fittings, such as faucets and stop-cocks, including all labor on same:

Drain and Soil Pipes (fittings included):

4" pipe, extra heavy, ...$1.00 per ft.
5" " " .... 1.25 "
6" " " .... 1.50 "

Vent and Waste Pipes:

2" pipe, extra heavy, ... .50 "
3" " " .... .75 "

Main Trap with Manhole and Cover.....$10.00
Leader Traps, 4"..... 3.00
5"..... ..... 4.00

Cesspools in Areas..... 2.00
Double-acting Force and Lift Pump.... 35.00
Hand or Cistern Pump..... 10.00
Ericsson Caloric Pumping Engine, 6-inch, about..... .....250.00
Rider Pumping Engine, 6 inch, about .. 450.00

	Gallons.					
	100	200	300	400	500	600
Tank, of wood, copper lined.	$15	$30	$40	$50	$60	$70
Wrought iron, painted.	$50	$65	$75	$85	$95	

Fittings for water tank complete, including ball-cock, stop-cock, overflow, blow-off, cistern valve.....$20.00

Kitchen Boiler, with water back connections, all necessary couplings, stop-cocks and boiler stand complete

	Gallons.						
	30	40	50	60	70	80	100
Of galv. iron...	$30	$35	$45	$50	$55	$60	$70
Of copper.....	40	50	—	75	—	90	120

Kitchen Sink, of cast-iron, completely fitted up, according to length and pattern, from.....$15 to $25

Add for galv. and enameling sink.	10 to 15
Of soapstone, from.....	20 to 35
Of slate, from.....	18 to 30
Of earthenware, from.....	25 to 40

Butler's Pantry Sink,

Of copper (24 oz.), from.....	$20 to $30
Of enameled iron, from.....	20 to 30
Of steel, painted.....	15 to 25
enameled.....	25 to 35
Of porcelain, from.	30 to 40
Add for waste valves or stand pipe overflow	10 to 15

Laundry Tubs, each tub fitted up completely.

Of wood	$12
Of slate	20
Of cement	25
Of artificial stone	15
Of soap stone	30
Of cast-iron (rustless)	18
Of porcelain, American	38
Of earthenware, imported	45

For a *set of two* deduct 5 per cent. from twice above sum.

For a *set of three* deduct 10 per cent. from three times above sum.

Water Closets.

Flushing-rim short hoppers, completely fitted up, excluding wood-work and tiling	$50
Improved washout closets	60
Improved hopper closets	75
Tiling for water closet walls and floors per square foot, complete, about	1.50
Slate or marble floor slabs, per square foot, about	2.00
Water closet seats (without covers)	$5 to $10
Bidet attachment	5 to 10
Gas jet ventilator attachment	10 to 15

Bath Tubs, of copper, 16 oz	$30
18 oz	35
20 oz	40

if fitted with chain and plug.

Add for waste valve or stand pipe overflow. $15
Enameled iron bath tub..... 60
Porcelain tub.....$180 to $200

Slop Hopper. Improved earthenware, flushing rim slop hopper, with cistern, marble back, etc .....$75 to $100

Urinals. Lipped Bedfordshire urinals, each fitted with flushing cistern...$30 to $40
Urinal stalls, of slate, for each stall.....$45
of marble, " 55

Wash Basins. Ordinary wash bowls, chain and plug, round.....$30 to $35
oval..... 33 to 38
Improved waste valve or stand pipe basin, round..... 40 to 45
oval..... 45 to 50

Water Supply Pipes (main lines).

For these a suitable sum should be added in the estimate. The amount will depend on sizes and material of supply pipes, size and number of stories of house, etc.

For general and preliminary estimates a rough idea of the cost of the work may be obtained by the following rule: *Count number of fixtures or set of fixtures* (counting the boiler and tank in) *and multiply same*

with 50 for ordinary, plain plumbing, iron supply pipes, plain but sanitary fixtures;

with 60 for very good, but plain plumbing, *i. e.*, best workmanship but plain fixtures;

with 75 for best quality plumbing materials, lead supply pipes, very best workmanship;

with 100 for very extensive and elaborate plumbing, including brass hot water pipes, nickel-plated holdfasts, including marble slabs and backs, but excluding all marble, slate or tile work for floors and walls and partitions:

The product represents in dollars the approximate cost of the work.

The cost of hot-air pumping engines is, of course, not included, and while the above figure covers cost of all connections between water back and boiler, it does not include the range nor any cabinet work in bath rooms, etc.

Where anti-siphon traps are used under fixtures, and vent pipes are accordingly omitted everywhere, the main system being very amply vented, the cost is reduced from 7 to 10 per cent. from above figures.

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